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Abstract

Study of Released Activity Distributions with Thermoluminescence Dosimeters

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As a complement to other experimental methods for the study of the behaviour of radioactivity released in free air or water, there is a need for a technique consisting of mapping the exposure distribution from a controlled discharge of for instance A^{41} in air or Br^{82} in water. From the radiation protection point of view, such work must be performed with the smallest possible amount of radioactivity. This implies that a type of dosimeter is required with which some tens of microroentgens can be measured, i.e. an exposure of the same order of magnitude as that caused by the natural background radiation during a few hours. The dosimeter should also be cheap and simple so that many measuring points can be used in an experiment.

These requirements eliminate most types of dosimeters, but are fulfilled by a dosimeter which we have developed on the basis of the thermoluminescent properties of $CaSO_4$:Mn. The thermoluminescence of this phosphor shows a high sensitivity to ionizing radiation. Its limited thermal stability does not cause any serious difficulties in controlled experiments. The dosimeters are contructed for measurements of exposures of gamma radiation only, and under laboratory conditions the reproducibility at 50 microroentgens is better than $\pm$ 20 % (standard deviation). In field experiments, the exposure to natural background radiation impairs the precision somewhat.

The feasibility of mapping exposure distributions with these dosimeters has been studied in some experiments. A^{41} was released in free air near the

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ground, and the exposures were measured in a vertical plane about 100 meters from the release point. Practical experience was satisfactory. This is also true for experiments in water with Br^{82}. These experiments will be described.

In many release problems, the concentration is the required quantity rather than the exposure. In air, the interpretation of the results in terms of concentration is complicated by the fact that activity at large distances from the measuring point contributes significantly to the exposure. This problem has been studied with numerical calculations. The spatial resolution is sufficient for most practical problems. This is also the case in water, where the photons have a short practical range.

The technique described is best suited for experiments on a relatively small scale, where the distance between release point and measuring point is less than say 200 meters. It has the advantage of providing a large number of measuring points in fixed positions. In many cases it can be used where other methods, including calculations, are questionable or impossible, as for instance in or near buildings and in vegatation. In this way, the technique can be a valuable complement to established methods for the study of the behaviour of radioactivity released in air or water.